DEVELOPMENT OF SOLAR DIGITAL THERMOMETER

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In the name of God, The Most Beneficent The Most Gracious

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ABSTRACT

Solar energy is one of the renewal energy to generate electricity. It produces electricity by heat engine or photovoltaic cell that converts the solar energy directly into electrical power. Nowadays, solar technology was use for electrical space heating and cooling in active and passive solar buildings, day lighting, hot water, thermal energy for cooking, and high temperature process heat for industrial purposes. In this project, the electric powers that have been produces from the solar panel will be use as an energy source to charge the digital thermometer battery. Mean that, the digital thermometer can operate although there is no sunlight in the period of time. To supply the required voltage to the digital thermometer, a regulator is needed to produce the required output voltage from the batteries. The project includes the analysis about the solar panel that will be used, build the circuit and program for the digital thermometer and develop the charger for the battery. For the digital thermometer, the LM35 had been used to measure the temperature. It can measure the temperature range; 0-99 degree Celsius. PIC 16F872 been used to read the voltage produce from LM35 and display it by seven segment as temperature in degree Celsius. The target of this project is to develop the solar digital thermometer that can show the surrounding temperature.

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ABSTRAK

Tenaga suria adalah tenaga yang boleh diperbaharui dan digunakan untuk menghasilkan tenaga elektrik. Perhasilan tenaga elektrik adalah dari pemanasan panel suria yang mengubah tenaga suria kepada tenaga elektrik. Pada masa ini, teknologi solar digunakan untuk pemanas elektrik, pencahayaan waktu siang, pemanasan untuk memasak dan pemanas bersuhu tinggi bagi industri. Untuk projek ini, tenaga elektrik yang terhasil daripada panel suria akan digunakan untuk mengecas bateri yang akan memberi kuasa kepada termometer digital. Ini bermaksud, termometer digital boleh digunakan walaupun tiada kuasa solar dalam masa tertentu. Voltage regulator digunakan untuk mengehadkan voltan daripada bateri untuk menghidupkan termometer digital. Projek ini merangkumi kerja menganalisis panel solar, mereka dan membina litar dan program untuk termometer digital dan membina pengecas bateri menggunakan sel suria untuk mengecas bateri. Termometer digital menggunakan pengesan suhu LM35 untuk membaca suhu. Ia boleh membaca suhu dalam lingkungan 0 sehingga 99 darjah Celsius. PIC16f872 digunakan untuk membaca keluaran dari LM35 dan memproses data lalu memaparkan suhu pada 7-segmen. Sasaran projek ini adalah untuk menghasilkan termometer digital suria yang boleh membaca suhu persekitaran.

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CHAPTER 1

INTRODUCTION

1.1 Overview

Solar energy is one of the renewal energy to generate electricity. It produces electricity by heat engine or photovoltaic cell that converts the solar energy directly into electrical power. Nowadays, the solar energy has been used widely because the energy has huge potential and it is clean for our environment.

The problem that leads me toward this project is many people didn't know how to apply renewal energy for the electrical devices. In this project, solar energy will be applied as energy source for the digital thermometer. Other than that, people did not alert of surrounding current temperature that can affect their health, although it is not obvious.

In this project, the electric powers that have been produces from the solar panel will be use as an energy source to charge the digital thermometer battery. Mean that, the digital thermometer can operate although there is no sunlight in the period of time.

To supply the required voltage to the digital thermometer, a regulator is needed to produce the required output voltage. LED will be used as the digital display for the thermometer. The project includes the analysis about the solar panel that will be use, build the charger, regulator and thermometer circuit and program for the digital thermometer.

For the digital thermometer, PIC16F872 will be used to control the digital temperature sensor, LM35 and the output will display using 7 segments. It will be large display and can be seen clearly. The program for the PIC will be compiled CCS C compiler.

1.2 Objective

The objectives of this project are to:

i. To develop the solar digital thermometer that shows surrounding temperature.
ii. To develop battery charger using electric energy from solar panel as energy source.
iii. To built 5V regulator circuit for the digital thermometer.
iv. To display the thermometer reading using large 7segment LED display.

1.3 Scope of Project

The elements that need to be proposed for the project are:

I. The solar panel.
   The specification of solar panel that will be used for this project is 17V, 5 Ampere.

II. Temperature
   The range of the temperature for this project is from 0.5°c to 95°c.

III. Place
   To install the solar digital thermometer, the place that been chosen must be able to get solar energy.

1.4 Problem Statement

The conversational digital thermometer today use battery as it source of energy. It must be replaced after the battery is low. Besides that, the thermometer used only for displays temperature and cannot be integrates with other related circuit. For my project, I used the solar energy to charge the battery that provide power to the thermometer and the thermometer reading is process by PIC microcontroller to display the reading and because of that, it is possible to integrate the thermometer to other related circuit such as temperature controlled circuit.

1.5 Thesis Organization

This thesis consists of 5 chapters all together. The first chapter is the introduction of this project. It is including the overview, objective, scope of project and the problem statement. This chapter explains about overall project in general. Second chapter is the

literature reviews where the contents are explain in literature aspect. Chapter 3 discusses about the methodology and chapter 4 is the result of this project. The last chapter will represent the conclusion of this project

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A review of the literature was performed to identify studies relevant to the topic. The keywords that I used in order to complete this literature review are solar energy, charger, voltage regulator, digital thermometer. The sources that I used are from the websites, journals and the previous reports.

2.2 Solar Energy

Solar electricity relies upon man-made devices such as solar panels or solar cells in order to provide a source of clean, and low cost renewable energy [1] means that human can used the solar energy by convert the solar into electric energy by using the solar panel or the solar cells. The semiconductor cell called a photovoltaic, or solar cell absorbs sunlight and transfers it into electricity, typically with 15-20% efficiency [2]. The size of the photovoltaic can affect the amount of electricity produces (Kribus, 2002).

The photovoltaic cells convert light into electric energy in atomic level. Some materials display a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons being captured, an electric current result that can be used as electricity [9].

The photovoltaic cells are made of semiconductor materials, such as silicon. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit, the electrons can be captured in the form of an electric current [9]. The current that that been produced by the photovoltaic cell is actually direct current (DC).

2.3 Charger circuit

A charger includes a battery pack receiving there in a plurality of batteries and having a projection provided with a contacting terminal [8]. The charger that will be used for this project eventually will received 17V and 5A electric from the photovoltaic cell and will charge 12 volt lead-acid battery. There are a lot of chargers in the market nowadays but only certain of it that used solar as the energy source.

2.4 Voltage regulator

A voltage regulator includes a capacitor providing a regulated voltage, a regulation switch for connecting the capacitor to a voltage source and a regulation circuit for closing the regulation switch when regulated voltage is below a first references voltage [7]. The use of voltage regulator is supply required voltage to the device (**Bruno Gailhard, 2002**). In this project, the regulator is use to convert supply from

batteries to required voltage for the Digital Thermometer. The input voltage from battery is 12V and the voltage regulator will convert it into required voltage of the circuit, which is 5V. For the voltage regulator circuit, LM7805 is used as voltage regulator.

2.4.1 LM7805

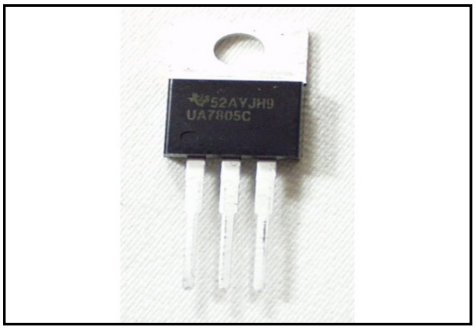

Figure 2.4: LM7805

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Voltage regulator, LM7805 actually having three legs, converts varying input voltage and produces a constant regulated output voltage. The 78XX are designed for positive voltage and the 05 at backside of the series shows the output voltage. The LM7805 series typically has the ability to drive current up to 1A. For application requirements up to 150mA, 78L05 can be used. The component has three legs: Input leg which can hold up to 36VDC Common leg (GND) and an output leg with the regulator's voltage. To get maximum voltage regulation, usually capacitor been added in parallel between the common leg and the output.

2.5 Digital thermometer

In 16th Century, Galileo formulated his “principles of thermo-dynamics” in creating thermometer [3]. The changes in the temperature will change the structure of some materials. As an example, the size of mercury will be increase when the

temperature increases. This concept been use in order to create thermometer in 16 century (Glyn Robins).

As the world change, the devices for measuring temperature also change. Nowadays, there are a lot of new device have been found to measured temperature. From the Omega.Com website, it mentions that temperature can be measured via a diverse array of sensors [3]. The sensor will detect the physical characteristic changes to infer temperatures changes. The examples of the devices are thermocouples, resistive temperature devices (RTDs and thermistors), infrared radiators, bimetallic devices, liquid expansion devices, and change-of-state devices.

The resistive temperature device has been definite as a device measuring temperature by the change of the electrical resistance of a metal wire (Houghton Mifflin, 2007). Beside that, other researcher has found the new device to measured temperature. As an example, Nor Aniza Mat Desa, from University Malaysia Perlis (UNIMAP) has used Barium Strontium Titanate (BST) sensor to create digital thermometer for her project.

2.5.1 Temperature Sensor (LM35)

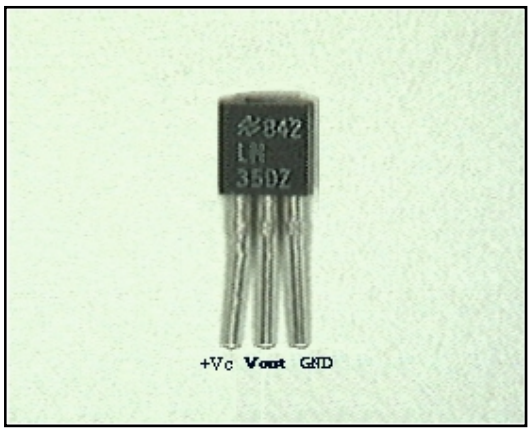

Figure 2.5: LM35

LM 35 is an intergrated temperature sensor that can gives electrical output proportional to the temperature in degree celcius (°C). This sensor can read temperature more accurate than using thermistor. The sensor also sealed to avoid the oxidation and the it can give higher output voltage than thermocouples and doesn‘t need additional voltage amplifier. LM35 can read from -50°C to 100°C and provides +/- 0.4 accuracies in rooms temperature and +/- 0.8 accuries over a range of 0°C to 100°C .

As mentioned above, LM35 provide output voltage proportional to the temperature in Celcius. The output is 0.01/1°C. It mean that if the output is 0.30V, the temperature is 30°C.

2.6 PIC 16F872

The PIC16F872 is a powerful and yet easy-to-program CMOS FLASH-based 8-bit microcontroller made by Microchip Technology. It only has only 35 single word instructions and makes it easy to use. The PIC16F872 features 64 bytes of EEPROM data memory, self programming, an ICD, 5 channels of 10-bit Analog-to-Digital (A/D) converter, 2 additional timers, a capture/compare/PWM functions and the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus.

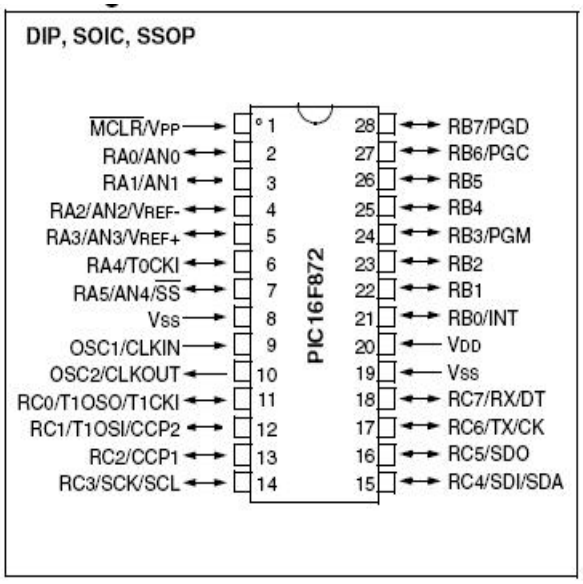

Figure 2.6.1: Pin description of PIC16F872

2.6.1 Programming

Programming is a core activity in the process of performing tasks or solving problems with the aid of a computer [11]. Computer cannot understand the specification given by natural language. Therefore, programming language is used to give instruction to the computer on how to solve the problem.

There is several language that can be use to classified the instruction. “High-level” programming language is one of them. "High-level" programming languages are languages whose syntax is relatively close to natural language, whereas the syntax of "low-level" languages includes many technical references to the nuts and bolts (0's and 1's, etc.) of the computer.

2.6.2 PICkits

THE PICkit is a low cost development kit with an easy to use interface for programming Microchips 8/14/20 pins flash family of microcontroller. It is design to help developers to speed up quickly using PIC microcontroller. It contains low pin count demo board supporting 8/14/20 mid range of microcontroller and the Windows programming selected flash based PIC microcontroller that easy to understand and use. The PICkit also use to write the program written by the programmers into the PIC.

Figure 2.6.2: PICkit

2.7 Digital display

Digital mean displaying numbers rather than scale positions [6]. Based on the definition of digital, the digital thermometer mean the device that can measuring temperature and display it into a numbers scale. 7 segments will be used to display the thermometer reading and by using it, the size of the display can be adjusted easily and it consume low power. Actually, the LED can be used to build large seven segment display

CHAPTER 3

Methodology

3.1 Introduction

This project actually been divided into certain part. It is including the development of solar battery charger, regulator and digital thermometer. The digital thermometer is involving the temperature sensor, PIC controller and it will be display by using LED display.

The figure below shows the energy flow from the solar panel through the charger and the digital thermometer. The electric energy from solar panel will flow to the charger and the charger will charge the battery. Although the regulator seem like to get source from the charger in the block diagram above, but actually the regulator will get the source from the battery and it will by pass the charger. The regulator will produce 5V to supply the digital thermometer.